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Research on Multi - function Smart Street Lamp Design Based on IoT

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Abstract: *With the rapid development of smart cities, traditional street lamps have failed to meet urban development needs due to shortcomings such as low energy saving, single function, poor controllable, and management system. This article uses street lamp as the cutout for smart traffic and designs "multi-pole-in-one" multi-functional street lamp products to achieve controllable lighting, epidemic prevention and temperature measurement, advertising display and other functions to help smart city construction.*

Keywords: *smart transportation, multifunctional street lamp, epidemic prevention and control*

1. Introduction

In February 2021, the state issued the Outline of the National Integrated 3D Transportation Network, which put forward the overall requirements, layout planning, key tasks and safeguards for the future construction, thereby developing and building a strong transportation nation with an attitude of scientific and technological innovation. [1] As roadside units and urban public infrastructure, smart street lamps play an important role in intelligent transportation, making urban roads "come alive" and urban economy usher in greater development space and opportunities. Besides, many places have recently imposed restrictions on electricity consumption due to complex factors. As a result, the energy-saving role of intelligent street lighting has become even more important.

2. Product Feature List

2.1. LED wisdom illumination

The traditional control method of street lighting causes a waste of energy, while the traditional manual inspection method has low operation and maintenance quality and efficiency.With the vigorous development of Internet of Things technology and LED technology, the combination of Internet of Things and LED makes the intelligent transformation of municipal lighting enter the fast lane.Wisdom combines each lamp with an infrared sensor, so that "when people pass by, the lamp lights up".At the same time, the light-sensitive sensor equipped on each lamp will adjust the brightness of the lamp according to the brightness and darkness, so as to avoid the waste of energy to the greatest extent.[2]

2.1.1. Photosensitive sensor module.

In this project, the photosensitive sensor adopts photosensitive resistor, which can sense the light and shade changes and output weak electrical signals.Through simple electronic circuit amplification processing, it can control the automatic switch of LED lamps and lanterns, and judge whether it is day or night by sampling different light values through single chip microcomputer.The design of the photosensitive sensor is shown in Figure 1 below.

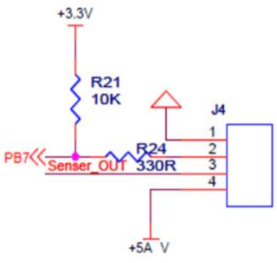

Figure 1: Photosensitive sensor module.

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2.1.2. Infrared sensor module.

Infrared sensor is a kind of sensor which uses infrared rays to process data, and has the advantages of high sensitivity.Infrared sensor can control the operation of driving device.When the module detects that there is a physical object passing in front, the green indicator light on the circuit board lights up, and the OUT terminal continuously outputs a low level.The infrared sensor module is shown in Figure 2 below.

Figure 2: Infrared sensor module.

2.1.3. Brightness level module (PWM to voltage module)

The light sensor judges that different brightness levels return to different brightness values, and the MCU generates PWM waves with different duty ratios through different brightness values, and the PWM-to-voltage module outputs different levels of voltage values to control the brightness of the lamp (the brightness of the lamp is affected by voltage).The PWM voltage conversion module can convert the PWM wave with a duty ratio of 0-100% into a voltage of 0-10V.The module is shown in Figure 6 below.

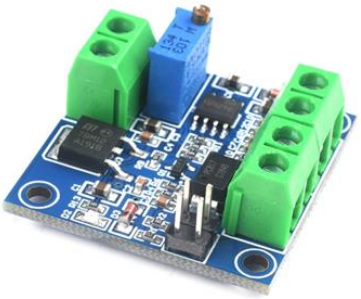

Figure 3: PWM to voltage module.

The light value returned by the photosensitive sensor is used to judge whether it is dark at present, and then the infrared sensor is used to judge whether someone passes.When someone passes, the MCU will generate PWM waves with different duty ratios according to different light values, resulting in different output voltage values and different brightness of the lamp.[3]

2.2. LED electronic display screen

Building a civilized and beautiful modern regional Central City cannot be separated from the effective publicity of information.When publishing information through mounting equipment, they have the effects of wide spread and great impact. Be equipped with LED electronic display screens, the smart street lamps can release government information, traffic information and commercial advertisements to realize the functions of playing separately at the same place, at different times, and increase product benefits.At the same time, smart street lamps support the mounting of various environmental modules and environmental monitoring, which can release air quality, temperature, humidity, wind power, wind direction, noise and so on on the LED screen in real time.The smart tower pole equipped with multimedia interactive terminal can also realize human-computer interactive communication through sensors.

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Figure 4: LED electronic display

Figure 5: Thermal sensor camera

2.3. Epidemic prevention

The smart street lamps are widely distributed in urban roads, streets, parks and other densely populated places. Through the deployment of thermal cameras on the poles, they are connected with the remote monitoring system, and the body temperature of pedestrians is obtained through thermal cameras, the facial images of people with abnormal body temperature are collected, detected, pretreatmented, matched and recognized to realize facial feature recognition. The facial recognition system can identify personnel and transmit data to relevant departments.

2.4. Smart Charging

The function of intelligent charging module is to provide electric energy support for electric vehicles with urgent charging demand, and can effectively improve the convenience of using electric vehicles in cities. The design method of the combination of charging pile, road lamp pole and parking space will greatly increase the number of charging pile points of urban new energy vehicles and effectively solve the problem of difficult charging of new energy vehicles in urban areas. The new idea of realizing low-carbon and environment-friendly travel smart street lamps are equipped with electric vehicle charging ports. The car owner can scan the QR code below the charging and charge the electric vehicle and pay the electricity bill through the mobile APP.It can realize remote centralized management and control of charging piles and meet the functions of monitoring, querying and locating the running status of charging piles.The charging pile function should be set when there is a parking space on the roadside of the smart street lamp.

Figure 6: Charging pile

2.5. 5G micro base station

The combination of 5G base station and smart street lamp can, on the one hand, solve the problem that the rigid demand of 5G micro base station for station site resources increases sharply due to the limitation of coverage; On the other hand, the power supply system of intelligent street lamp pole can be used to solve the cable laying problem in the construction of 5G micro base station.Smart street lamp is the most basic component unit of urban lighting system, which covers every corner of the city, and naturally becomes the core communication hub of deploying the "neuron level" of all things intelligent link, namely the best terminal carrier of 5G base station.As the communication connection point, the smart tower pole can be extended to the outside through wireless or wired means, providing a variety of business services, including wireless base station, Internet of Things, edge computing, public WIFI and optical transmission, etc.In addition, the intelligent tower pole covers a wide area and is close to the

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connected objects. It is suitable to be the carrier of the Internet system, receiving, integrating and transmitting information from various fields of the city anytime and anywhere through various connection methods, improve the intelligence level and management efficiency of the city.

3. NB-IOT Technology

The development of Internet of Things communications promoted the construction of intelligent street lights. The low-power WAN (LPWA) technology in recent years is designed to meet the requirements of long distance and low power consumption in the IoT. LPWA includes multiple technologies such as NB-IOT, LTEEMTC, LORA, SIGFOX.Among them, NB-IOT technology is a new radio access network technology introduced by 3GPP, using 200 kHz carrier technology. Dissemination of discontinuous reception in NB-IOT is based on periodic wakeup, you can use sleep mode to save power transmission data.Many User Equipment (UEs) can be supported by a single NB-IOT, each NB-IOT channel supports more than 100,000 user equipment.Therefore, billions of connections can be added to the network through NB-IOT to add additional carriers to the network.

4. Conclusion

In this article, taking street lamps as the entrance of smart transportation, the design of multifunctional street lamps with "multi-poles in one" will greatly improve the level of traffic informationization, promote the development of smart transportation, realize energy conservation and emission reduction, help epidemic prevention, beautify the urban environment and build an environmentally friendly, efficient and beautiful intelligent city.

Compared to traditional street lights, this product has obvious advantages. On the one hand, the product is more energy efficient, as it not only determines the brightness of the street light based on information such as location and time, but also controls it in real time by analysing the current traffic and pedestrian flow on the road. On the other hand, this product focuses on local adaptation and is equipped with specific functions according to specific needs, avoiding the problem of under-utilisation of some functions. In addition, with the rapid development of technologies, the street light becomes an excellent terminal carrier for 5G micro-base stations and collaborative adaptive cruise control systems, with a promising future.

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